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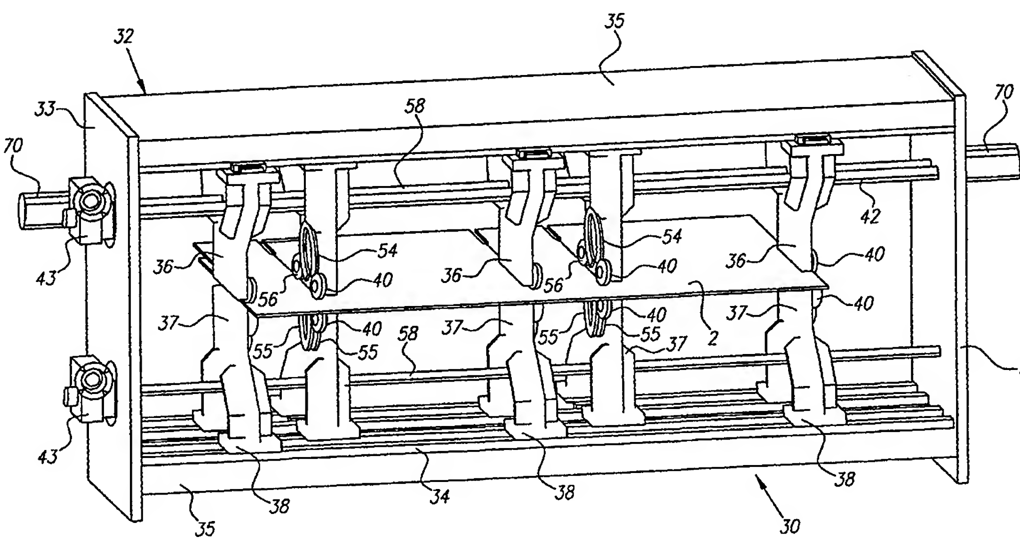

(57) Abstract

An independently driven slotter unit (30) for slotting paper board material includes frame assembly (32) having a conveying path (4) therethrough for board (2) travel. The slotting head (46) above the conveying path (4) is preferably the male slotting head having an arcuate blade (54) thereon for cutting leading and trailing slots in a bord (2). The male slotter head (46) is independently driven such that it can rapidly rotate and stop depending on the orientation of the board. The ability of the male slotting head to pause in a dwell position permits boards of virtually unlimited length to be trimmed with a single blade (54).

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DESCRIPTION

Independently Driven Slotter Unit

Background Of The Invention

The field of the invention is devices used in the rotary slotting, scoring, printing, and die-cutting of corrugated and solid-fiber paper board or other like materials.

Slotting units in combination with printer units and/or die-cutters are commonly used in the processing of corrugated and solid-fiber paper board. Often, Printer-Slotters, Printer-Slotter-Die-cutters and Flexo-Folder-Gluers (also referred to as Casemakers within the trade) are used by the corrugated converting industry for the manufacture of Regular Slotted Cartons (RSC's). RSC's are conventional boxes that are sometimes referred to, in the trade, as regular slotted cartons. For the manufacture of RSC's, a variety of units are preferably employed, with each unit performing a different operation on the board. A typical system could comprise a feeding unit, one or more printing units, and a slotting and scoring unit. In some instances a die-cut unit and folding unit with counter-collector could be also be employed.

These units are typically connected together in a linear arrangement in the board feed direction so that a board of corrugated material or solid fiber (generally referred to as "board") that is to be processed, passes from one unit to the unit adjacent to it. This process can be repeated any number of times with different units until the board exits the last unit. At the completion of each unit's processing, the board is further converted, with the starting position generally accepting a flat sheet of board, and the ending position being at any stage up to and including the complete transformation of the board into a printed, slotted, scored, die-cut, folded and glued box.

Figure 1 illustrates the traditional slotting and scoring operation on a sheet of unprocessed board which has been slotted and scored (creased) in four places to produce an RSC. Generally, producing a RSC requires the following actions to be performed: (1) a series of leading slots are cut into the board and removed to produce leading flaps, (2) center creases are formed to produce a body panel, and (3) trailing slots are cut and removed to produce trailing flaps.

Typically, the individual process units have been gear driven or connected through a line-shaft wherein each modular unit has main cylinders of the same working circumference that act upon the board. Other units however, may be independently driven wherein the units are electrically coupled to ensure synchronized motion through a mechanical connection. However, in both the electrical and mechanical synched designs, the cylinders are all rotating at the same revolutions per minute (RPM) so that the outer surface of the cylinders that are coming into contact with the board are all traveling at the same speed as the board.

As stated previously, a scoring operation is preferably used in the preparation of RSC's. Scoring is typically accomplished by the use of one or two sets of vertically opposed scoring shafts to which are fitted upper and lower scoring heads. The heads are located in the same vertical plane such that the upper head directly opposes the lower head. The upper head is fitted with or otherwise has machined into it a particular profile, while the lower head is fitted with or otherwise has machined into it another particular profile such that when a sheet of board is transported horizontally through and between the nip formed between these two profiles, a scoring (or creasing) effect is applied to the board.

The scoring heads are required to be moved laterally (i.e., transversely along the shafts on which they reside) for each size of box that is to be produced. The lateral

position of the scoring heads defines the location of the scores and therefore the folding line for the panels of the box. The scores produced on the box are lined-up with the slots (in lateral position) to form an RSC.

Slotting is also a required operation in the formation of a RSC. Slotting generally refers to the process where either one or two sets of vertically opposed slotter shafts are fitted with upper (usually male) and lower (usually female) slotter heads. The slotter heads are located in the same vertical plane such that the upper head directly opposes the lower head. The upper head is typically fitted with a replaceable male slotter knife, usually consisting of two sections of an otherwise circular cutting blade, the circumference of which is equal to the repeat length of the machine on which the slotting unit is installed and its thickness defining the thickness of the slot that will be removed from the board. The lower head is generally fitted with two female slotter knives, consisting of otherwise fully circular blades, spaced apart marginally wider than the thickness of the male blade that opposes it, and located in a lateral sense on either side of the male blade.

The vertical distance between the male and female blades is set such that as board is transported into the nip formed therebetween, the rotating male blade penetrates the board and enters the gap between the two female knives, causing a shearing or cutting effect on either side of the male slotter knife. The leading male knife is generally "tipped" to aid the ejection of the cut slot from the board as the board continues to travel in the direction of the ejected slot scrap.

Prior slotting units generally consist of two alternative configurations. (See Figures 1, 2(a), and 2(b)). In one design, the slotter has one set of slotting shafts, with the male slotter head affixed with two slotting blades (the leading knife and the trailing knife as seen in Figures 1 and 2(a)). One blade is fixed in relation to the head,

while the other is able to be rotated circumferentially in relation to the first such that the space between the trailing edge of the first and the leading edge of the second defines the depth of an RSC's body.

In an alternative design, as seen in Figure 2(b), the slotter unit has two sets of slotting shafts, with just one male slotter in each slotter shaft. The advantage of this design is that it is less frequently required for the operator to change blades to achieve different box configurations (e.g., short slots and long body pieces compared with long slots and short body pieces). The disadvantage, however, is that a second slotting shaft adds considerable additional mass and manufacture cost to a slot-score unit.

Printing units may also accompany any slotter and scorer units in the process of RSC's. Printing is not a mandatory operation in the processing of RSC's, but is virtually always included. Generally, the act of printing requires a printing cylinder having a working diameter equal to the repeat length of the machine. To effect printing, a printing plate (also referred to as a printing stereo or printing cliché) is mounted to this cylinder. The printing plate is typically made from a malleable photopolymer material of up to approximately 1/4″ in thickness, with raised areas that will pick up ink as it comes into contact with a rotating anilox roll. As the printing cylinder rotates, the ink is transferred from the plate to the board as it passes past and against the printing plate. An impression cylinder presses the board lightly against the printing plate to ensure correct transmission of the required print. All three cylinders (print, anilox and impression) are generally mechanically or electrically coupled to ensure they all have exactly the same circumferential velocity as they make contact with the board that is to be printed on.

Die-cutters may also be included in the RSC producing process. Die-cutters generally have two cylinders with working diameters that are generally identical to the repeat length of the machine, with an upper cylinder located directly above a lower cylinder. A pathway between the upper and lower cylinders forms a nip, through which the board that is to be processed (in this case die-cut) travels through. The die-cutting cylinder generally has bolt holes evenly spaced over its outer surface such that a cylindrically shaped cutting and creasing tool can be bolted thereon. The opposing anvil cylinder is generally fitted with a surface to accept the impact of the cutting and creasing tools, often being urethane covered blankets into which the cutting tool can penetrate as it cuts through the board that is transported through the gap between these two rotating cylinders.

All of these processes above generally involve the use of major active cylinders that are of the same working diameter. These cylinders rotate at the same RPM to give the same circumferential speed as each contacts with the board on its travel through the machine. The circumference of these cylinders corresponds to the "repeat length" of the machine.

The repeat length of a machine is a term used to generally describe the circumference of all the major active cylinders that act upon a board as it passes through the various units that process it. The repeat length defines the maximum board depth that can be acted on by any one cylinder before the cylinder has made a complete 360° revolution. Boards longer than the repeat length therefore would undergo a second processing were the board to be any longer than the machine's repeat length.

The "maximum board length" is usually a length somewhat shorter than the repeat length. The difference in lengths results from the cycle time required by the feeder to accelerate a sheet of board from its stationary state in the

feed unit up to machine speed. Other limitations to the maximum board length can include a locking mechanism required to mount and retain a printing plate on a print cylinder, which reduces its effective diameter. Therefore depending on various factors that will be peculiar to each machine's design and capability, the maximum board depth will typically be about 85% to about 95% of the repeat length for the same machine.

The process known as "skip feed" refers to a method commonly used in the corrugated converting industry to process a board that has a length a little beyond a machine's maximum board length. By feeding one board for every two cycles of the machine (instead of one board for every one cycle, as is normal), a longer board can be fed, printed, slotted, scored and die-cut, provided certain limitations or restrictions are taken into account. Skip feed essentially requires the feeding of boards deliberately out of register or synch with the machine, so that different units of the machine can act on the different portions of the board. The problem of "overrun" is not experienced as this takes place in the spacing between the fed boards that result from feeding one board every two cycles.

Unfortunately, limited benefit is derived from the skip feed operation due to the limitations that accumulate as the required board length grows beyond the normal maximum board length. For example, in the processing of RSC's, the unit that limits the maximum board length that can be processed in skip feed operation is often the slotter-scorer unit. In this unit, the maximum length of board that can be processed into an RSC will be limited according to the circumferential length of the slotting blade or blades.

The other limitation in the processing of RSC's occurs with respect to the maximum through-machine length of the board (or box) that can be printed. The maximum print (MP) is generally defined by the length of the board (B) being processed and the repeat length (RL) of the machine,

according to the formula MP = RL - (B - RL). As an example, if a 75" board can be processed in skip feed on a 66" circumference machine, then the MP = 66" - (75" - 66") = 57". The application of print every cycle (i.e., every rotation) of the print cylinder means that a larger board to be slotted and scored results in significantly reduced printing capability. Consequently, on large boxes, print of even a small nature will repeat down the length of the box. Previous slotter-scorer units are thus unable to process much larger boards than the circumference of the major cylinders of the machine without repetition of the print application.

Consequently, there is a need to create a device capable of increasing the size of boards that can be run through a scorer, slotter, and printer, without having to increase the diameter of the cylinders.

Summary of the Invention

In a first separate aspect of the invention, a slotter unit for slotting a paper board material includes a frame assembly including a conveying path therethrough. A pair of opposing slotter heads for producing leading and trailing slots in the paper board material are rotationally mounted to the frame assembly, one of the opposing slotter heads being rotationally mounted above the conveying path and the other slotter head being rotationally mounted below the conveying path. One of the opposing slotter heads is independently driven of the other such that the rotational speed of the independently driven slotter head is controlled to alter the distance between the leading and trailing slots in the paper board material.

In a second separate aspect of the invention, the first aspect further includes a pair of opposing yokes adjustably mounted relative to the frame assembly, one of the opposing yokes being above the conveying path and the other yoke being below the conveying path. In addition, a pair of male

and female opposing slotter heads are rotationally mounted in the opposing yokes, with the male slotter head being above the conveying path and the female slotter head being below the conveying path. The male opposing slotter head is independently driven such that the male slotter head is controlled to alter the distance between the leading and trailing slots in the paper board material.

In a third separate aspect of the invention, a method of slotting a paper board material with leading and trailing slots is provided. The method comprises the steps of introducing a board into a nip region of a conveying path formed between a male and female slotter. The male slotter is then accelerated to the line speed of the board such that line speed is achieved when the board comes into contact with the male and female slotters. A leading slot is formed in the board with the male and female slotters. The male slotter is then decelerated from line speed to a stationary or near stationary position during which the board advances through the nip without being slotted. The male slotter then re-accelerates to the line speed of the board such that line speed is achieved when the board comes into contact with the male slotter for cutting the trailing slots. A trailing slot is formed in the board with the male and female slotters. Lastly, the male slotter is rotated in either the clockwise or counter-clockwise direction in preparation of the next board.

In yet another separate aspect of the invention a method of printing on paper board material is provided. The method contemplates introducing a paper board material into a nip formed in the conveying path of a board between a printing cylinder and an impression cylinder. Ink is transferred from the printing cylinder to the board passing through the nip. Either the printing cylinder or the impression cylinder is disengaged from the board such that the size of the nip is increased so that ink is not transferred to the board.

In a further separate aspect of the invention, combinations of the foregoing separate aspects are contemplated. Thus, an object of the invention is to provide an improved slotter and method of slotting. Other and further objects and advantages will appear hereinafter.

Brief Description of the Drawings

FIG. 1 is a perspective view of a slotter-scorer unit according to the prior art.

FIG. 2(a) is a side view of a slotter-scorer unit according to the prior art.

FIG. 2(b) is a side view of a slotter-scorer unit according to the prior art.

FIG. 3 is a perspective view of one of the opposing yokes with the first pair of creasing heads, slotter heads, and second pair of creasing heads shown.

FIG. 4 is a perspective view of a slotter unit illustrating the opposing yoke orientation.

FIG. 5 is a further perspective view of a slotter unit illustrating the opposing yoke orientation from above.

FIG. 6 is a perspective view of a slotter unit illustrating the frame assembly and drive train of the unit.

FIG. 7(a) is a plan view of one of the opposing yokes.

FIG. 7(b) is cross-sectional view of the opposing yoke of FIG. 7(a) taken along the line 1-1.

FIG. 8(a) is a schematic view of the operation of the slotter unit showing the first and second pair of creasing heads and the slotter heads with the male slotter head in the acceleration zone.

FIG. 8(b) is schematic view of the operation of the slotter unit showing the slotting of the leading slots in a board.

FIG. 8(c) is another schematic view of the operation of the slotter unit showing the first and second pair of creasing heads and the slotter heads with the male slotter head in the deceleration zone.

FIG. 9(a) is schematic view of the operation of the slotter unit showing the dwell or convey position of the male slotting head.

FIG. 9(b) is another schematic view of the operation of the slotter unit.

FIG. 9(c) is schematic view of the operation of the slotter unit showing the slotting of the trailing slots in a board.

FIG. 10(a) is a schematic view of a printing operation performed on a board with the print cylinder in the disengaged position.

FIG. 10(b) is a schematic view of a printing operation performed on a board with the print cylinder in the engaged position.

FIG. 10(c) is a schematic view of a printing operation performed on a board with the print cylinder moving to the disengaged position.

Detailed Description Of The Preferred Embodiment

With reference to the drawings, a description of the slotter unit will now follow. The present invention is directed to a design and method of operation that provides the capability to process larger sized board materials than would otherwise be possible in current devices, while being itself physically smaller and costing less to manufacture when compared with prior designs.

With reference to Figures 1, 2(a) and 2(b), a brief description of the prior art process will now be described. In previous unit designs, a board 2 passes along a conveying path 4 in the direction of arrow A. Located above the conveying path 4 is a slotting shaft 6 that is positioned perpendicular to the direction of board 2 travel (arrow A). Located on the slotting shaft 6 is a male slotting head 8. The slotting head 8 has attached thereto two male slotting knives 10. Alternatively, as shown in Figure 2(b) there are two male slotting heads 8, with each having one knife 10

thereon. A corresponding female slotting head (not shown) is located below the conveying path 4. In the device shown in Figure 2(a), one of the knives 10 on the male slotting head 8 is used to create the lead slot 12 while the opposing knife 10 creates the trailing slot 14. A plurality of male slotter heads 8 with associated knives 10 are used to create additional leading and trailing slots 12, 14 on the board 2.

In a similar fashion, a creasing shaft 16 contains a male creasing head 18 having defined shaped or geometry and is located above the conveying path 4. A corresponding female creasing head (not shown in Figure 1) is located below the conveying path 4. The creasing head 18 impinges on the board 2 passing through the conveying path 4 to form the desired crease.

A print cylinder 20 is preferably located below the conveying path 4 of the board 2. To print, the print cylinder 20 having a printing plate 22 thereon comes into contact with the board 2, where ink located on the exterior thereof transfers to the board 2.

As can be seen from Figures 3, 4, 5, and 6, the present invention is directed to a slotter or slotter unit 30. The slotter unit 30 preferably includes a frames assembly 32 that contain the various working components of the slotter unit 30. Within the frame assembly 32 is a conveying path 4 through which board 2 passes during operation. Preferably, two side frames 33 and upper and lower cross-ties 35 make up the frame assembly 32. Spanning the side frames 33 of the slotter unit 30 are preferably located a plurality of linear rails 34 that are preferably mounted to the cross-ties 35. Slidably mounted to certain of the plurality of linear rails 34 are a plurality of opposing yokes 36, 37. The plurality of opposing yokes 36, 37 can thus slide laterally along the linear rails 34. As can be seen from Figures 3 through 6, the opposing yoke arrangement preferably has one of the opposing yokes 36 located above the conveying path 4 and the

other opposing yoke 37 located below the conveying path 4. This arrangement creates the male-female orientation of the slotters and creasers. A plurality of yokes 36, 37 can be slidably attached to the linear rails 34 for the creation of additional slots in the board 2.

The yokes 36, 37 preferably have a pair of feet 38 that create a sliding engagement with the linear rails 34. The yokes 36, 37 are thus capable of sliding along the linear rails 34 in a direction perpendicular to conveying path 4 to adjust their position relative to the board 2. The yokes 36, 37 are preferably made of a sturdy material such as cast iron or case steel. Referring now to Figure 3, a first creasing head 40, a male slotter head 46, and a second creasing head 56 are all rotatably mounted to a yoke 36. Vertically opposing the yoke 36 is an opposing yoke 37 (not shown in Figure 3) that contains a first creasing head 40, a female slotter head 48, and a second creasing head 56 which are all rotatably mounted to a yoke 37. The opposing yokes 36, 37 thus create a pair of first opposing creasing heads 40 rotationally mounted in the opposing yokes 36, 37, a pair of opposing slotter heads 46, 48 rotationally mounted in the opposing yokes 36, 37, and a second pair of opposing creasing heads 56 which are rotationally mounted in the opposing yokes 36, 37. The slotter heads 46, 48, the first pair of creasing heads 40 and the second pair of creasing heads 56 are rotatably mounted to the yokes 36, 37 through the use of bearings 64.

When a plurality of yokes 36, 37 are employed, differing yokes for different slots are preferably offset or interlaced from one another such that the feet 38 of adjacent yokes 36, 37 enter corresponding recesses in the yokes 36, 37 as seen in Figure 4. Also, to achieve smaller minimum panel widths, the reduced width of the yoke means that the slotter heads 46, 48, can be brought much closer together, particularly when interlaced on a second rail set on each linear rail 34 as can be seen in Figure 4.

The design eliminates the conventional slotter shaft 6 rotating support structure. The design supports the slotter heads 46, 48 and creasing heads 40, 56 from yokes directly between lateral supporting cross-ties 35, riding on linear rails 34, thus significantly reducing the inertia of the structure that is to be rotated during operation.

With reference to Figure 3, 4, 5, and 6, a description of the slotter heads 46, 48 will now be given. Preferably, the male slotter head 46 resides above the conveying path 4 of the slotter unit 30 in yoke 36 with the female slotter head 48 being below in yoke 37. The male slotter head 46 preferably has teeth 49 located around its circumference. The teeth 49 engage with an intermediary gear 50 located on the yoke 36 for transferring rotation from a primary rotation gear 52. The primary rotation gear 52 preferably is connected to a sliding sleeve 53 which traverses throughout the yoke 36. A rotating shaft 58 passes through the primary rotation gear 52 and is preferably splined or keyed such that it rotates when the sliding sleeve 53 rotates.(See Figures 5 and 6, and 7(a).

The rotating shaft 58 and sliding sleeve 53 are rotated by servos 70 mechanically engaged or coupled therewith. The servos 70 are preferably independently driven from the drive train that powers the creasing heads 40, 56 and the female slotter head 48. In this regard, the rotational power source of the male slotter head 46 is thus independent and separate from the rotational power source of the creasing heads 40, 56 and female slotter head 48.

Preferably, a pair of servos 70 are located on opposing sides of the rotating shaft 58. The servos 70 work in concert with one another to accelerate and/or decelerate the male slotter head 46 to the desired rotational speed. The presence of two servos 70 aids in reducing any adverse torsional forces that can develop in the rotational shaft 58 during operation.

As can be seen from Figure 6, further included in the slotter unit 30 is a separate means for powering the female slotter 48 and the creasing heads 40, 56. A separate drive shaft for scoring 42 traverses the unit 30 through the upper yokes 36 to power the creasing heads 40, 56. The drive shaft for scoring 42 is rotatably connected to a gear box 43 preferably located on the exterior of the frame assembly 32. The gear box 43 connects to a drive source to power the creasing heads 40, 56 at or near line speed.

The female slotter heads 48 are driven in a similar fashion. The female slotter heads 48 are mechanically connected to a female drive shaft 58 for slotting that traverses the unit 30 through the lower yokes 37 to power the female slotter heads 48. The female drive shaft 58 for slotting is rotatably connected to a gear box 43 preferably located on the exterior of the frame assembly 32. The gear box 43 connects to a drive source to power the female slotter heads 48 at or near line speed.

Referring to Figures 7(a) and 7(b), a single male slotting blade 54 is preferably attached to the male slotter head 46. The blade is preferably made of one piece but can be made of two or more individual components. The blade has an arcuate shape, having an angular sweep of about 220° to about 320°. The male blade 54 is used to produce both the leading slots 12 and trailing slots 14 of a board 2.

A female slotter head 48 is located vertically opposite the male slotter head 46 below the conveying path 4. The female slotter head 48 is preferably fitted with two female slotter knives 55, spaced marginally wider than the thickness of the opposing male blade 54. A slotting nip 51 is thus formed in the conveying path 4 of the board 2. The slotter unit 30 can contain any number of opposing yokes 36, 37 with slotter heads 46, 48. The number of slotter heads 46, 48 depends on the desired number of slots in the RSC.

As recited previously, the male slotting head 46 having the male slotting blade 54 is driven by an independent (from

the main power train) servo 70 or other drive means. A separate drive source is preferred as a rapid and accurate acceleration and deceleration of this blade is required to create leading and trailing slots on boards having longer than normal lengths.

To assist in transferring smaller boards 2 (in the board travel direction) through the slotter unit 30, an additional wheel or drive means can be optionally included that rotates at the line speed and is located above the female slotting knife 55 and preferably to one side of the male slotting blade 54. The purpose of the wheel or drive means is to grip the board in a similar fashion as the creasers so as to permit the board 2 to be securely transported during the manufacture of the body portion of the box's manufacture. Without this feature, the minimum body panel length that could be converted would be the length between the nip of the first creasing head 40 and the second creasing head 56. This feature advantageously reduces the minimum length by about half.

Referring now to Figures 8(a) through 8(c), a description of the slotting and scoring operation according to the present invention will now be described. Prior to the first board 2 entering the slotter unit 30, an independent servo 70 for the male slotter head 46 rotates the male head 46 with attached blade 54 to an advanced position that permits the same to ramp to line speed. That is, the engagement position of the blade 54 with the board 2 is at a point on the circumference of the male blade 54 equal to the intended leading slot length B, plus the acceleration zone A that is required to accelerate the male head 46 with blade 54 from 0 RPM to line speed. The length of zone A may vary according to the line speed of the machine (i.e., the faster the speed the machine is running at, the more space it requires to accelerate up to machine speed).

Just prior to the board 2 entering the slotter nip 51, the male slotter heads 46 are accelerated so that all male slotters 46 across the unit 30 are rotating at line speed by the time the leading edge of the board 2 reaches the point of engagement (slotting nip 51) of the male slotters 46 and female slotters 48. As the board 2 reaches the slot nip 51, the cutting of the slot commences and continues at line speed (i.e., the male slotter head 46 is rotating such that the effective circumferential rotation speed of the male blade 54 matches the speed of the board 2).

Having been pre-set for the slot length, the tipped end of the slotter blade 54 reaches the lateral score line where the slot is to finish and cuts the end of the slot, with the blade's raised tip aiding in the forward ejection of the slot waste. Referring now to Figure 8(c), zone C is shown, which serves a different role compared to zone B in that zone C is for the deceleration of the slotter blade 54 and male head 46 from line speed to either a slowed speed or a stationary speed.

During the deceleration phase C, the male slotter 46 decelerates to a stationary or near-stationary speed to assume a "dwell" position as can be seen in Figure 9(a). During this dwell position, the first and second creasing heads 40, 56, and female slotter heads 48 all continue to rotate at line speed, advancing the board 2 through the slotter nip 51. The male slotter 46 remains in this dwell position to allow the board 2 to travel through the unit 30 without forming the trailing slots. This dwell feature thus permits a theoretically infinitely long body depth.

As the trailing end of the board approaches, the formation of the trailing slot commences wherein the male slotter head 46 is again accelerated, in this case using a corresponding zone D to accelerate to line speed so that when the male blade 54 pierces the board 2 at the second lateral score-line, it is now traveling at the same speed as the board being processed.

With reference to Figures 9(c), a description of the later portion of the slotting process will now be described. The male slotter heads 46 with associated blades 54 continue to rotate at line speed until the end of the board 2 is reached. It is then necessary for the male slotter head 46 to rotate back into the position required for the entry of the next board 2, as recited previously in 8(a). Depending on the amount of rotation required to get to this initial position, the male slotter head 46 may rotate in machine direction or counter-machine-direction (clockwise or counter-clockwise directions). Generally, the direction which will bring the male slotter head 46 in the required position the quickest is preferable. The time available to move to this position is defined by the distance between boards 2 divided by the rate at which the boards 2 are being fed per minute. In some cases it may be necessary to reduce the machine running speed or run in skip feed so that sufficient time is available for the male slotter 48 head to be rotated from position seen in Figure 9(c) to the position illustrated in position 8(a).

As recited previously, on a conventional slotter unit, each 360° rotation of the slotter head must produce a lead slot, the body panel and the trailing slot. Therefore the working circumference of the blade 54 defines the maximum total board length that can be fed into the unit. For example, on a 66" circumference machine, if a typical RSC was 25% leading flaps, 50% body and 25% trailing flaps, the maximum board 2 that could be processed would be 16½" + 33" + 16½" = 66".

Unlike prior devices, the current slotter unit 30 uses one blade 54 of approximately 270° of the 66″ circumference (49.5″) to cut both the leading slots 12 and trailing slots 14, while the approximately 90° (16.5″) of un-bladed circumference can produce an infinitely long body panel. For example, on a similarly sized 66" circumference, if a typical RSC was 25% leading flaps, 50% body and 25% trailing

flaps, the maximum board that could be processed would be 49½" + 99" + 49½" = 198". This is about three times as large a board 2 as on the conventional slotter. Consequently, the male slotter head 46 and blade 54 working diameter can probably be reduced to around 40" in circumference while still maintaining the capability of processing larger boxes than can be processed with a conventional unit.

The slotter unit 30 as described herein thus can operate without the relatively large shafts that both support and rotationally drive the slotter and creaser heads. This also eliminates the associated hardware such as journal ends, bearing housings and assemblies. In a conventional machine, a substantial amount of bulk is required in the supporting shafts 6, 16 due to the loads that are imparted at the center of the shafts 6, 16 (mid-point between side-frames) which will tend to deflect the shafts 6, 16. This is particularly true during the slotting and scoring of heavy weight board 2. Moreover, the wider the unit, the more mass that is required, and hence additional structure is needed. By incorporating a shaftless design, the mass of the slotter unit 30 is substantially reduced. However, the rigidity is still achieved by using the cross tie(s) 35 to support the opposing yokes 36, 37 that hold the rotating slotter heads 46, 48 and scoring heads 40.

The primary benefit of the present design is that much more function is derived from each circumferential portion of the male slotter head 46 and blade 54 than on a conventional slotter blade/head assembly. As seen in Figure 1, on a conventional slotter there is generally one knife blade to remove the leading slot 12 and a second knife blade for the trailing slot 14, with the spacing between the blades defining the body depth. In contrast, the present unit 30 utilizes a servo motor 70 and low inertia design that allows one male knife blade 54 to be rotated rapidly

enough to cut both the leading slots 12 and trailing slots 14 while pausing in its "convey" position so that the body length can be any desired length.

The secondary benefits of the slotter unit 30 includes the increased flexibility in regard to the maximum and minimum board 2 size that can be processed on any given machine. The elimination of the shafts 6, 16 and other components reduces manufacturing costs in addition to creating an easier installation. The male slotter head 46 with blade 54 is capable of moving into its next order position substantially faster than a conventional slotter. The male slotter blade 54 can rotate radially into the engaged position very quickly due to its low mass and independent (e.g., servo) power source 70. In addition, the yokes 36, 37 can preferably be moved laterally in less time without the need for precision movement on the tight tolerance of a slotter shaft 6.

In a separate aspect, a method of interrupting a printing and die-cutting process is described. The present method of printing or die-cutting is contemplated to be used in situations where the board 2 that is to be processed is longer (in machine direction) than the circumference of the print cylinder 80 which carries the printing plate 82. The printing plate 82 is mounted for printing onto the exterior of the print cylinder 80. Alternatively, a die-cut cylinder that carries a cutting tool for cutting into the board 2.

Unlike the aforementioned method and apparatus in which the rotation of the male slotter head 46 is accelerated and decelerated while the caliper (distance between the male slotter head 46 and the female slotter head 48) remains fixed, in this method the rotation of the print cylinder 80 or die-cutting cylinder remains constant and the caliper is adjusted such that the print cylinder 80 or die-cut cylinder goes into and out of engagement with the board 2.

In the sequence of diagrams shown in Figures 10(a) through 10(c), a typical printing situation is illustrated

in which "cycled interrupt" printing is performed, wherein the board 2 being processed is twice the length of the circumference of the printing cylinder 80. In such a situation, the portion of the board 2 that requires printing is between the transverse score line (i.e., the body panel of the box)(Figure 1).

In the case of a die cutting operation, the reverse situation may apply in that the portion of a board 2 that would require transformation may be the leading and/or trailing flaps (i.e., the portion of the box other than the body panel). However, the concepts as applied and described for printing is identical for die-cutting.

With reference to Figures 10(a) through 10(c), a large portion of the circumference of the cylinder 80 is required as printed area, so the remaining 'non-printing' portion of the cylinder circumference (referred to as the Engagement/Disengagement Zone 84 or ED Zone 84) is small. The relationships between the variables of machine running speed and the ED Zone 84 is that as the ED Zone 84 is reduced, the theoretical maximum running speed of the machine must be correspondingly reduced as less cycle time is available for the print cylinder 80 to complete its motion.

Other variables that affect the theoretical maximum running speed of the slotter unit 30 include the amount of warp in the board 2 that is to be processed and the board 2 rigidity. If the board 2 is very rigid and also has warp, the board 2 does not lie flat but tends to bend or curl in certain areas. It is therefore difficult for the transfer units 86 to pull the board 2 flat at the nip point 83 between the impression cylinder 81 and print cylinder 80. As such, it can become necessary to open the nip 83 between the impression and print cylinders 81, 80 further than normal to ensure that the board 2 comes in contact with the printing plate 82. Therefore the relationship between the variables of machine running speed, the caliper distance and

warp is that as the amount of warp and/or rigidity of the boards 2 increases, the range of motion of the engagement and disengagement must be greater. Consequently, the theoretical maximum running speed of the machine must be reduced. Typically, a computer program will calculate what this maximum running speed will be according to the fixed machine constants of the cycle time of the ED mechanism and the cylinder weights and inertia's involved, plus the variables that apply for the particular job being processed.

Referring now to Figures 10(a) through 10(c), a method is illustrated with the printing cylinder 80 and impression cylinder 81 being moved into and out of an engagement position. The impression cylinder 81 and board transfer units 86 remain on a fixed horizontal plane. Alternatively, this can be reversed with the printing cylinder 80 fixed and the impression cylinder 81 and board transfer apparatus being cycled in and out of an engagement position.

As the board 2 enters the nip 83 between the impression cylinder 81 and printing cylinder 80, the printing cylinder 80 is disengaged such that no print will be applied to the leading portion of the board 2, even though the trailing portion of the printing plate 82 is at the 12 o'clock position and would otherwise be in contact with the board 2 and therefore printing.

As the print cylinder 80 rotates in the direction of arrow C to a position where the trailing end of the printing plate 82 is at the 12 o'clock position (which coincides with the beginning of the ED zone 84), the ED mechanism commences its cycle, bringing the printing plate 82 up to the engaged position, just prior to the point at which the raised portion of printing plate 82 reaches the 12 o'clock position. The print cylinder 80 then commences printing on the board 2 that is now sandwiched between the print cylinder 80 and the impression cylinder 81.

During the printing period, the printing plate 82 is rotated with the print cylinder 80 as close to the same

tangential velocity as the board 2 that is passing against it. Immediately upon completing the print, the ED mechanism commences the return portion of its cycle, pulling the printing cylinder 80 and printing plate 82 down to the disengaged position such that the print cylinder 80 rotates and presents the leading edge of the print plate back 82 to the 12 o'clock position. The printing plate 82 is thus completely disengaged such that no print is applied to the trailing portion of the board 2 passing through.

While embodiments and applications of this invention have been shown and described, it would be apparent to those skilled in the art that many more modifications and substitutions of known equivalents are possible without departing from the scope of the invention. The invention, therefore is not to be restricted except in the spirit of the appended claims.

Claims

1. A slotter unit for slotting paper board material comprising:

a frame assembly including a conveying path therethrough for the paper board material to pass and;

a pair of vertically opposing slotter heads for producing leading and trailing slots in the paper board material, the opposing slotter heads being rotationally mounted to the frame assembly, one of the vertically opposing slotter heads being a male slotter head holding a single, segmented male slotter blade and further being rotationally mounted on a first side of the conveying path and the other slotter head being a female slotter head holding a pair of female slotter blades, the female slotter head being rotationally mounted on a second side of the conveying path, said male slotter head being independently driven of the female slotter head such that the rotational speed of the male slotter head is controlled to alter the distance between the leading and trailing slots in the paper board material.

2. A slotter unit according to claim 2, the male slotter head being located above the conveying path, and the female slotter head being located below the conveying path.

3. A slotter unit according to claim 1, the male slotter head having a single arcuate blade affixed thereto, said arcuate blade being accelerated or decelerated by the independently driven slotter head so as to alter the starting and ending points of the leading and trailing slots.

4. A slotter unit according to claim 3, the unit further including an independent drive assembly for rotating

the male slotter head separately from the female slotter head.

5. A slotter unit for slotting paper board material comprising:

a frame assembly including a conveying path therethrough for paper board material to pass;

a pair of opposing yokes adjustably mounted relative to the frame assembly, one of the opposing yokes being above the conveying path and the other yoke being below the conveying path;

a pair of male and female opposing slotter heads rotationally mounted in the opposing yokes, said opposing yokes bearing the load of the male and female opposing slotter heads which is contained by the frame assembly during board processing, the male slotter head rotationally mounted in the yoke on a first side of the conveying path and female slotter head rotationally mounted in the yoke on a second side of the conveying path.

6. A slotter unit according to claim 5, the frame assembly including a plurality of rails to which the opposing yokes are adjustably mounted, and through which the load exerted to the yokes via the slotter heads is distributed through the slotter unit.

7. A slotter unit according to claim 5, further including at least one set of scoring heads rotatably mounted to the opposing yokes.

8. A slotter-scorer unit for scoring and slotting paper board material comprising:

a frame assembly including a conveying path therethrough;

a plurality of rails spanning the frame assembly;

a pair of opposing yokes slidably mounted to the plurality of rails, one of the opposing yokes being above the conveying path and the other yoke being below the conveying path;

a first pair of opposing creasing heads rotationally mounted in the opposing yokes, one of the opposing creasing heads rotationally mounted in the yoke above the conveying path and the other creasing head rotationally mounted in the yoke below the conveying path;

a pair of male and female opposing slotter heads rotationally mounted in the opposing yokes, said opposing yokes bearing the load of the male and female opposing slotter heads which is contained by the frame assembly during board processing, the male slotter head being rotationally mounted in the yoke on a first side of the conveying path and the female slotter head rotationally mounted in the yoke on a second side of the conveying path;

a second pair of opposing creasing heads rotationally mounted in the opposing yokes, one of the creasing heads rotationally mounted in the yoke above the conveying path and the other creasing head rotationally mounted in the yoke below the conveying path;

an independent drive assembly for rotating the male slotter head that is independent of the female slotter head, the first pair of creasing heads, and the second pair of creasing heads.

9. A method of slotting paper board material with leading and trailing slots comprising the steps of:

introducing a board into a nip region of a conveying path formed between a male and female slotter;

accelerating the male slotter to the line speed of the board such that line speed is achieved when the board comes into contact with the male and female slotters;

forming a leading slot in the board with the male and female slotters;

decelerating the male slotter from line speed to a stationary or near stationary position during which the board advances through the nip without being slotted;

accelerating the male slotter to the line speed of the board such that line speed is achieved when the board comes into contact with the male slotter; and

forming a trailing slot in the board with the male and female slotters;

rotating the male slotter in either the clockwise or counterclockwise direction in preparation of introducing the next board.

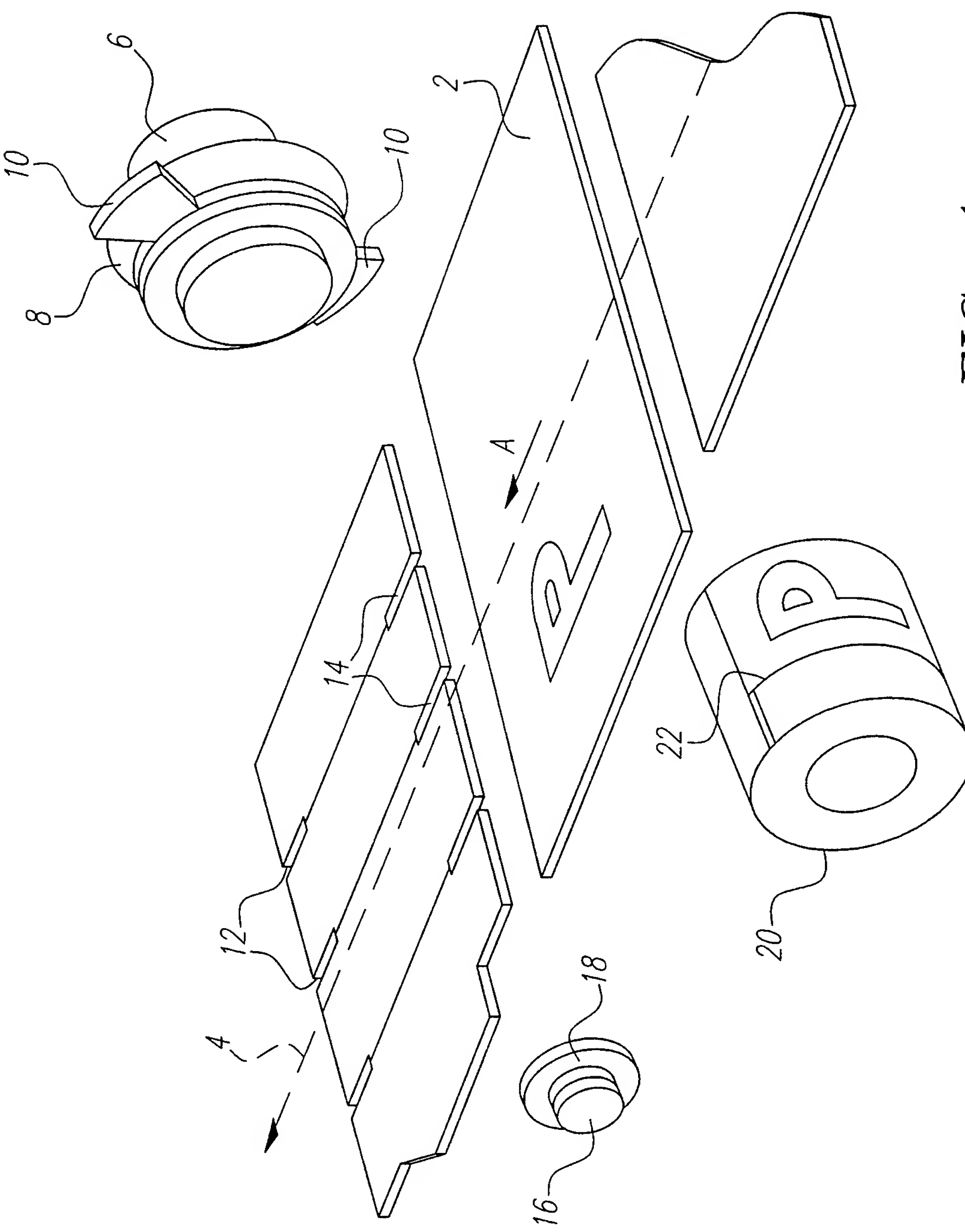

FIG. 1
(PRIOR ART)

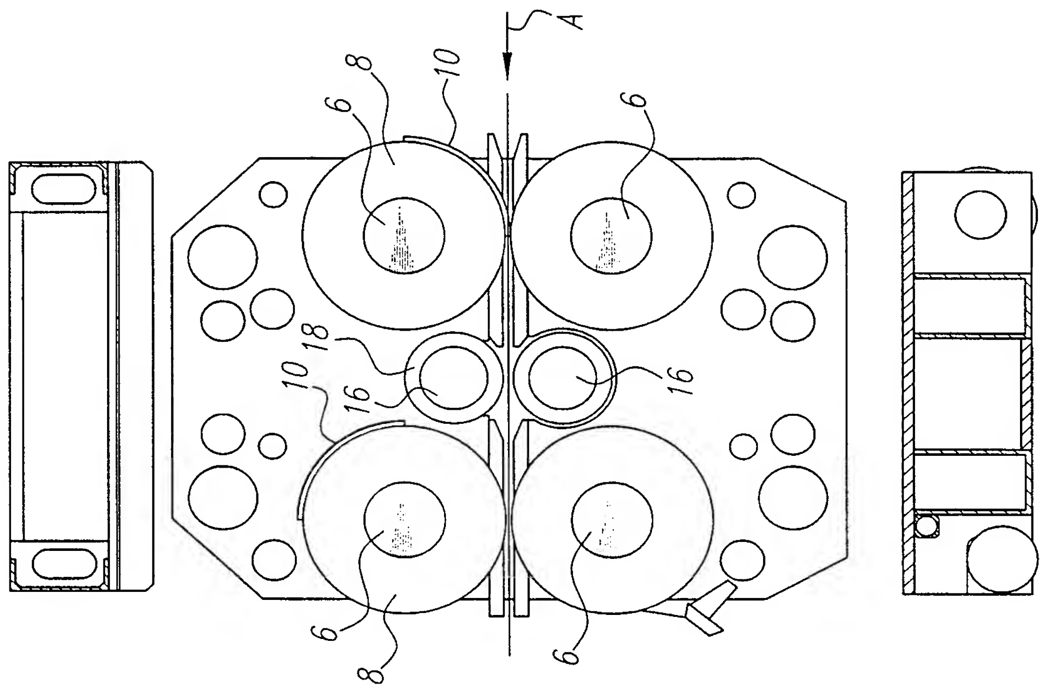

FIG. 2(b)
(PRIOR ART)

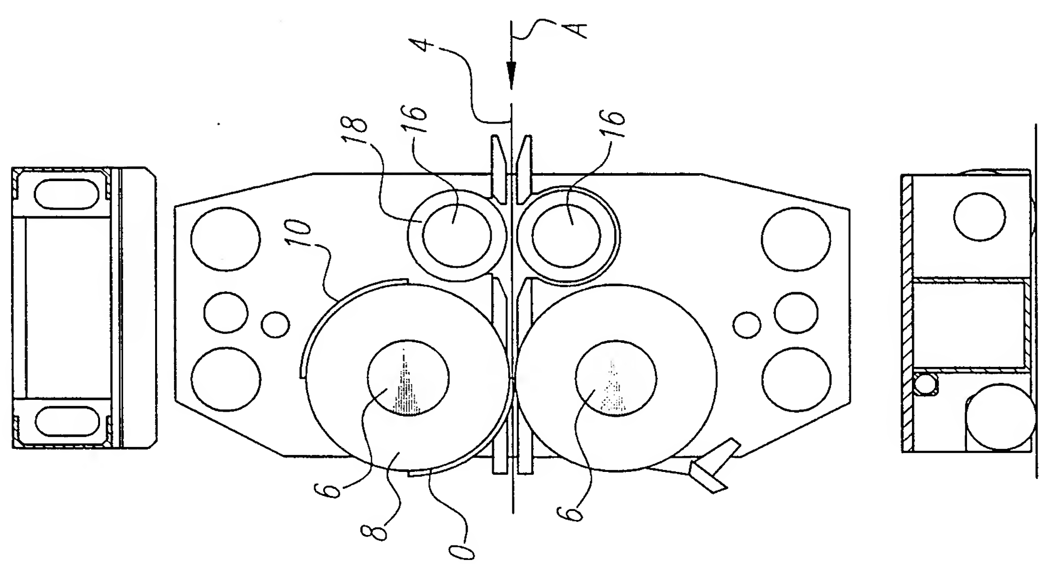

FIG. 2(a)
(PRIOR ART)

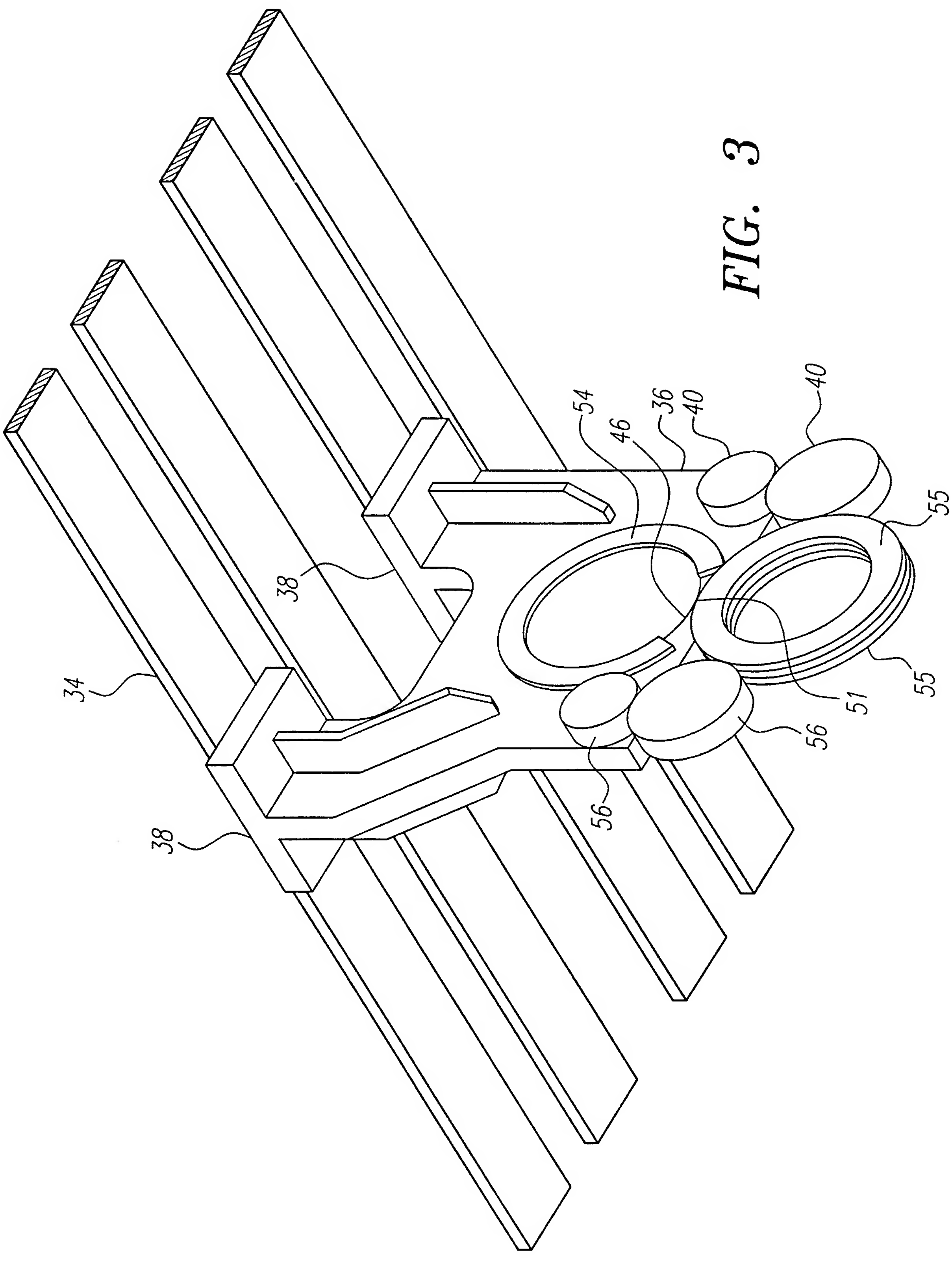

FIG. 3

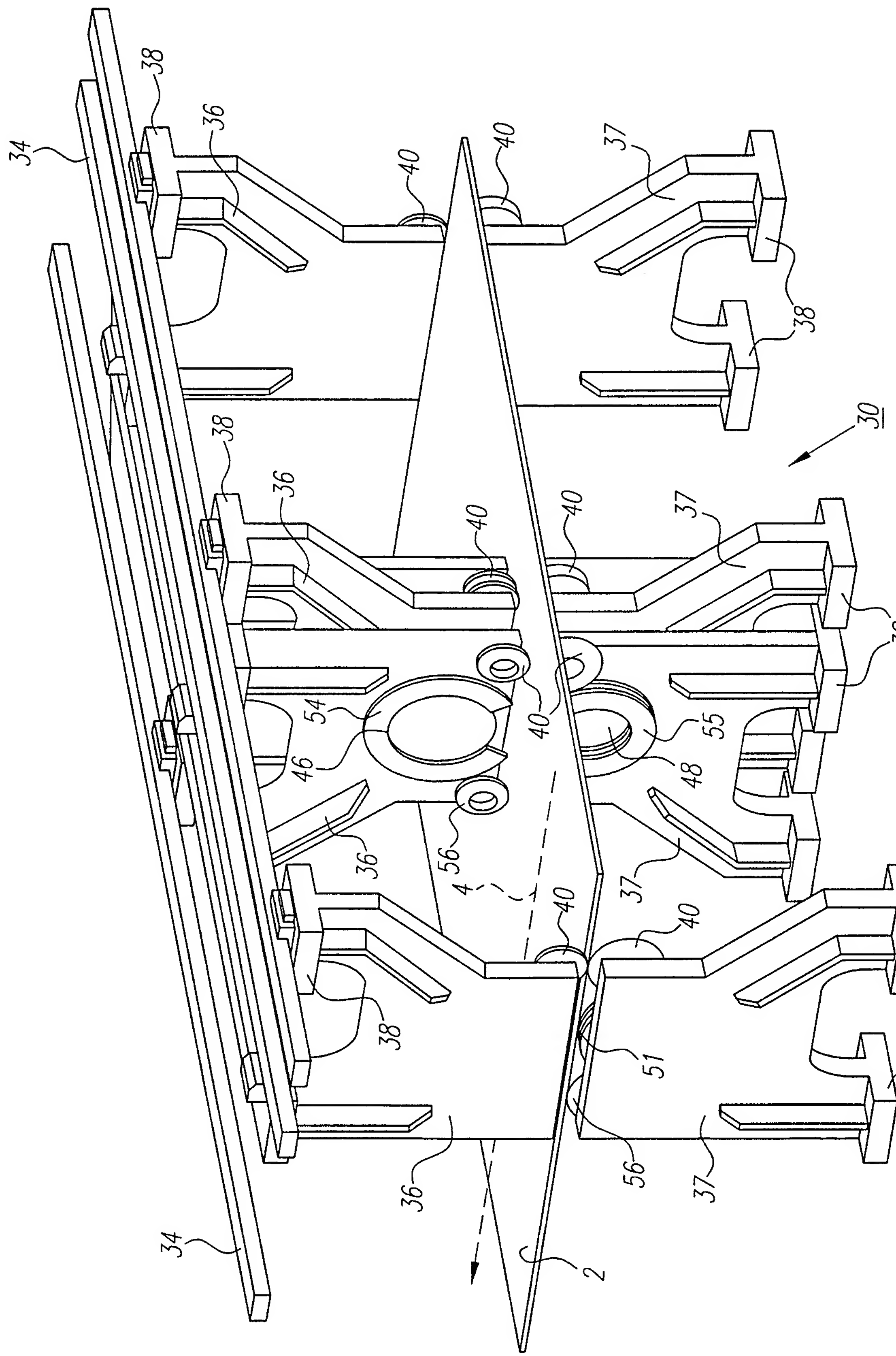

FIG. 4

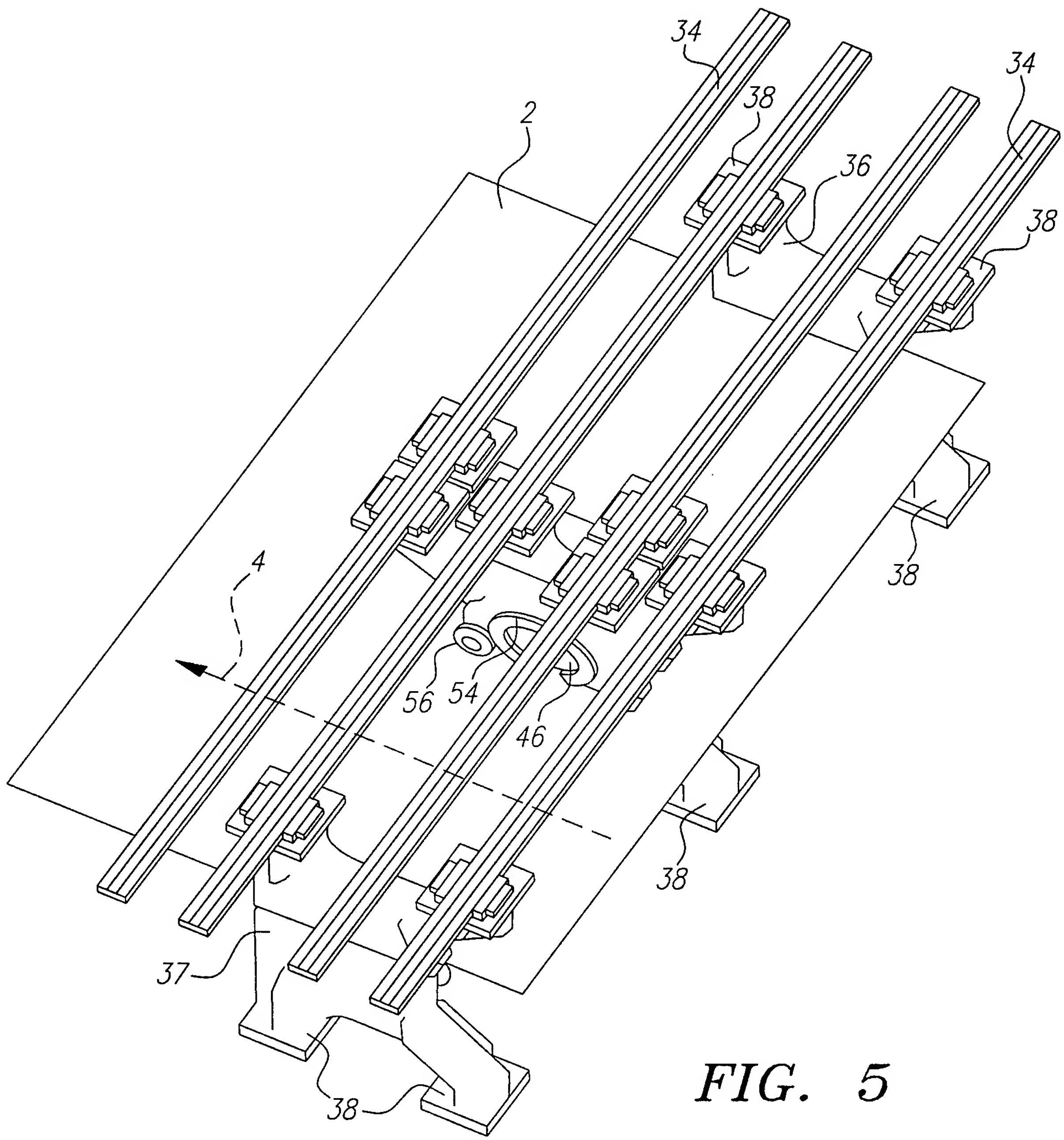

FIG. 5

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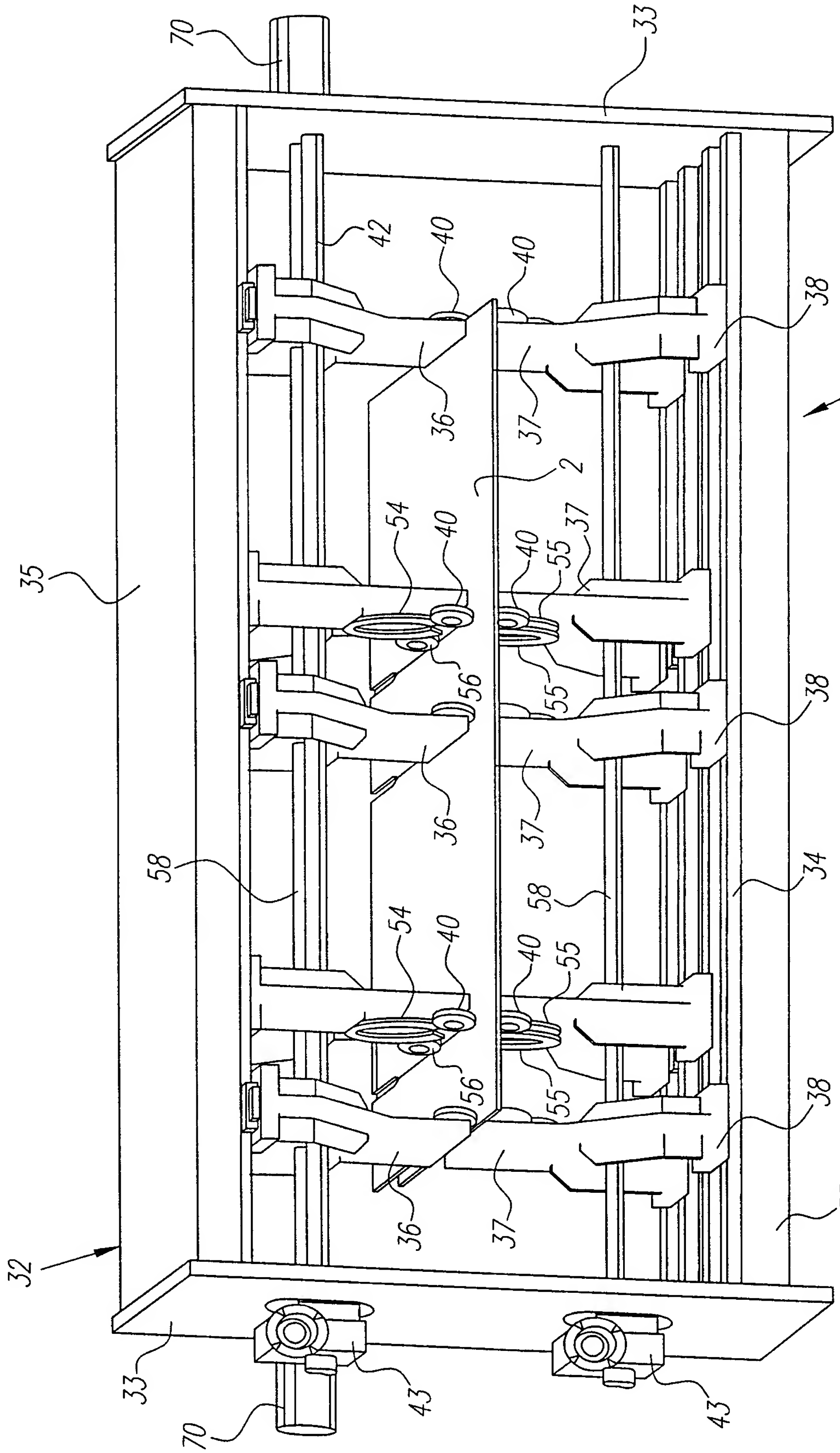
70
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FIG. 6

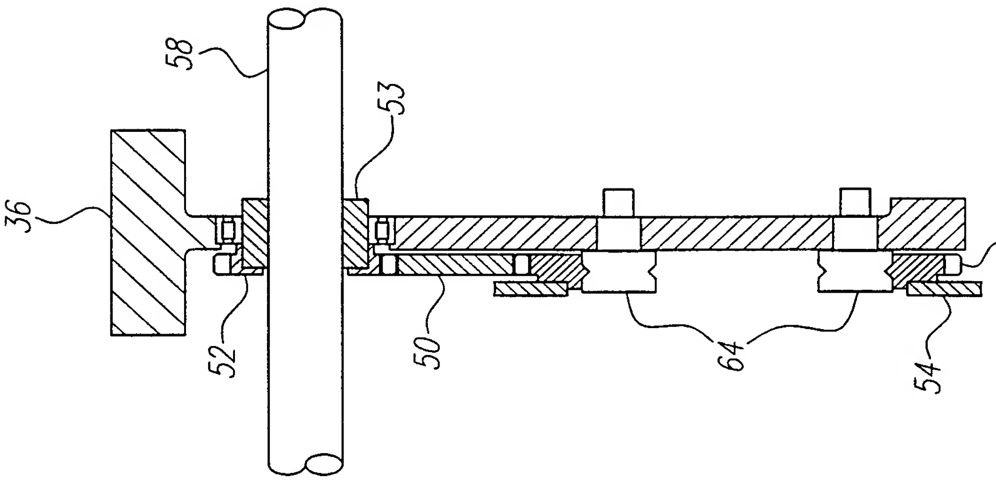

FIG. 7(b)

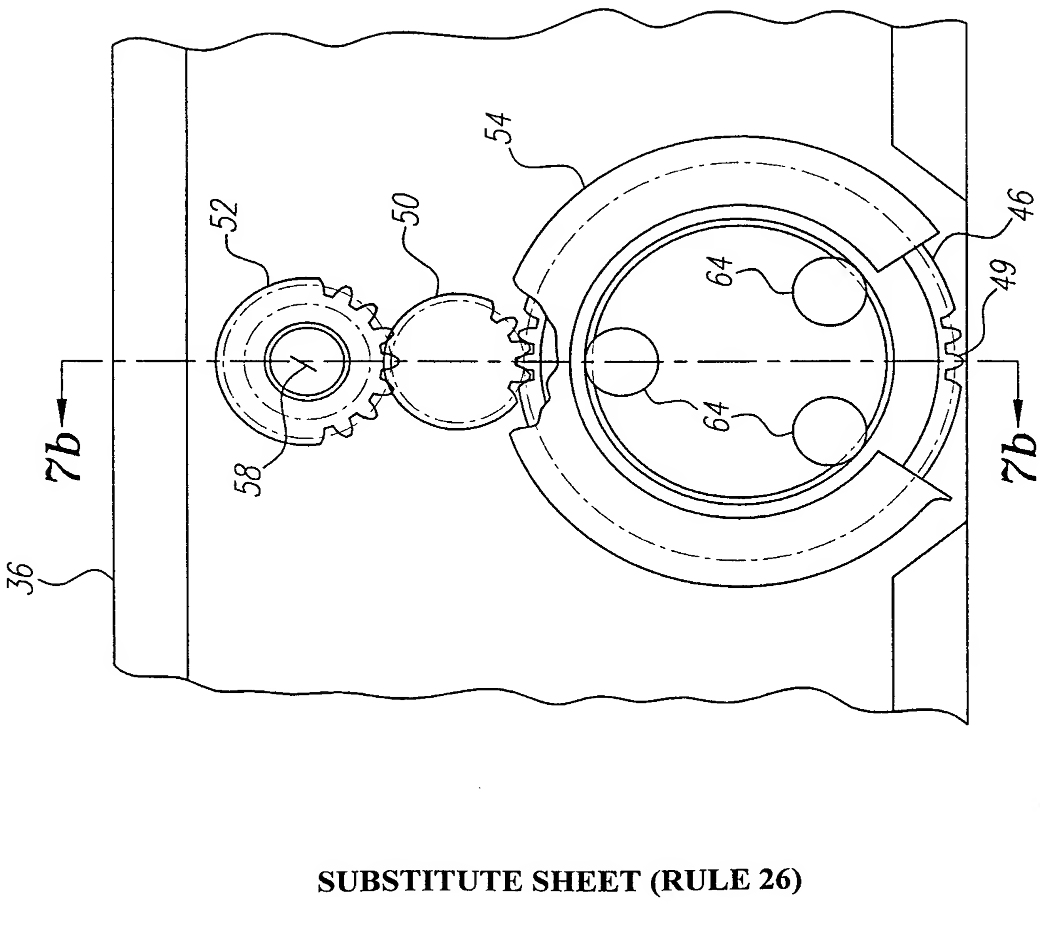

FIG. 7(a)

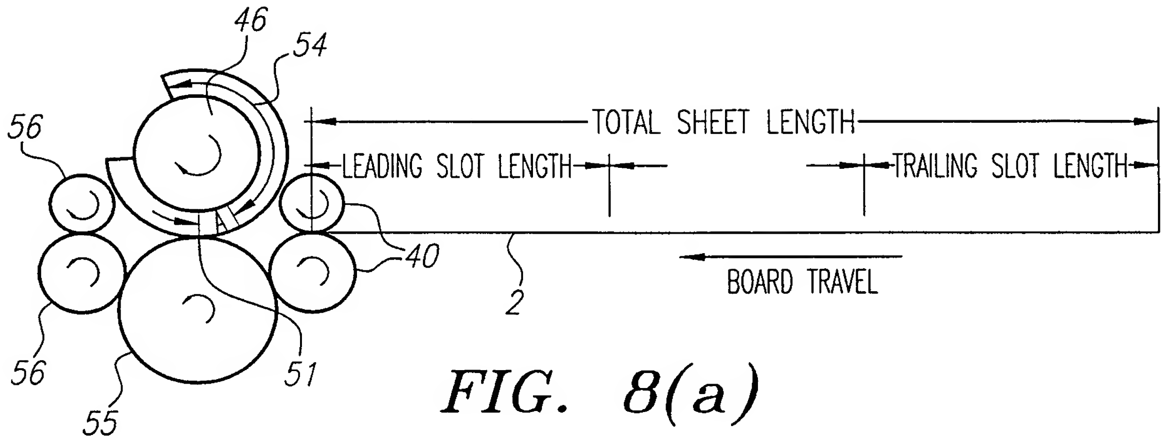

FIG. 8(a)

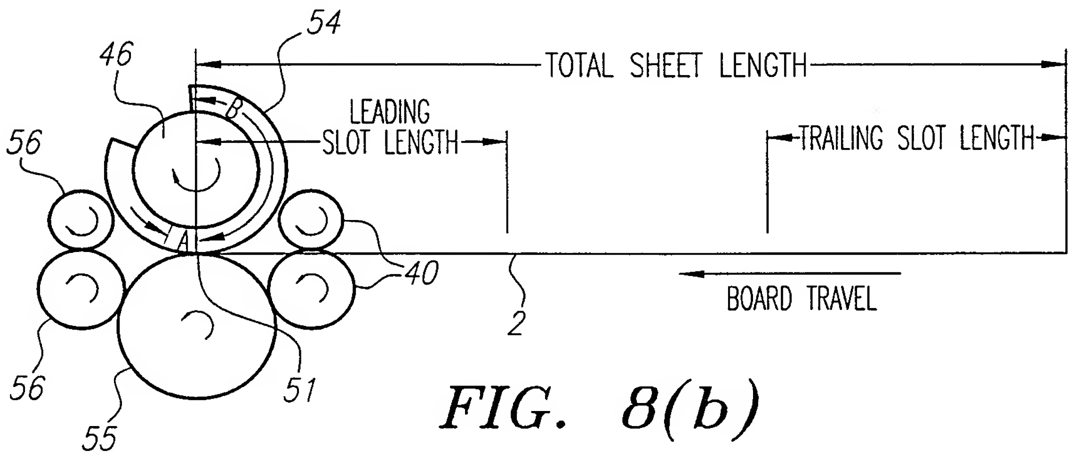

FIG. 8(b)

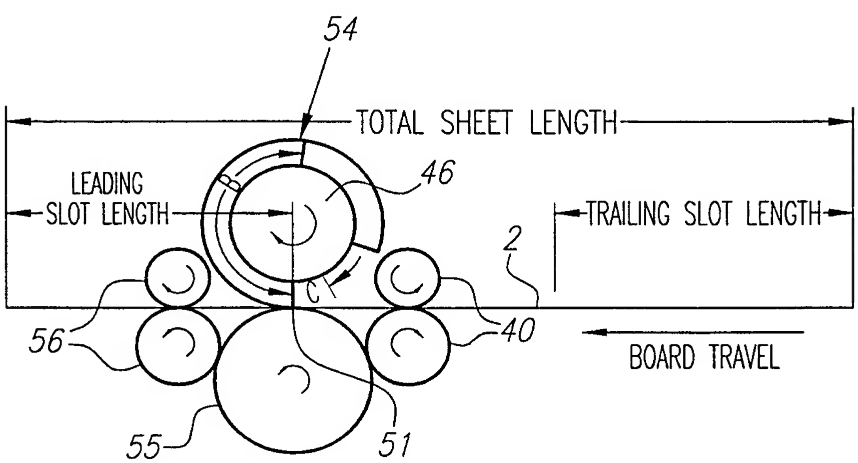

FIG. 8(c)

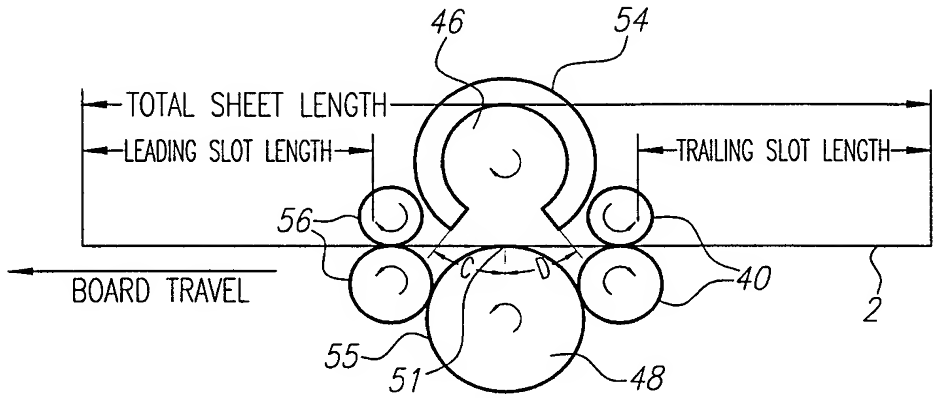

FIG. 9(a)

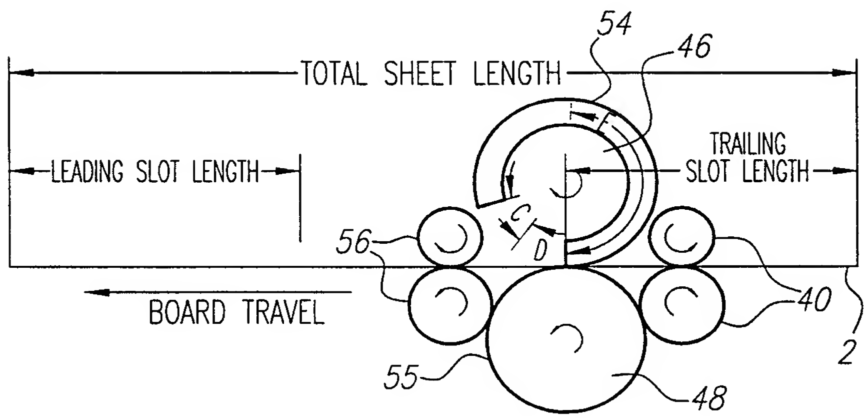

FIG. 9(b)

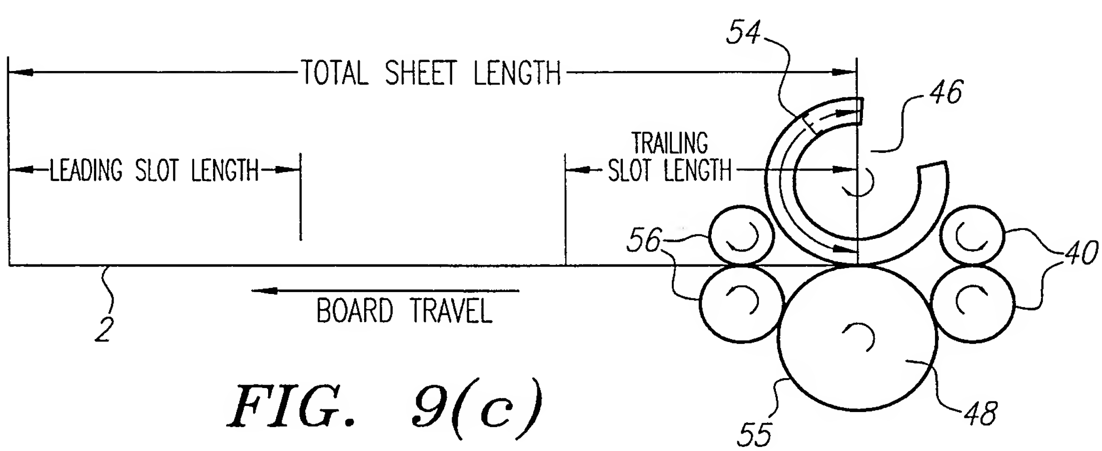

FIG. 9(c)

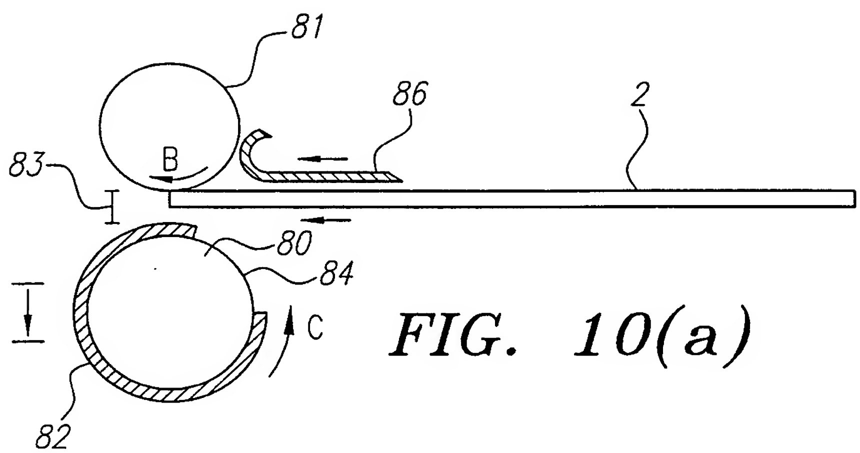

FIG. 10(a)

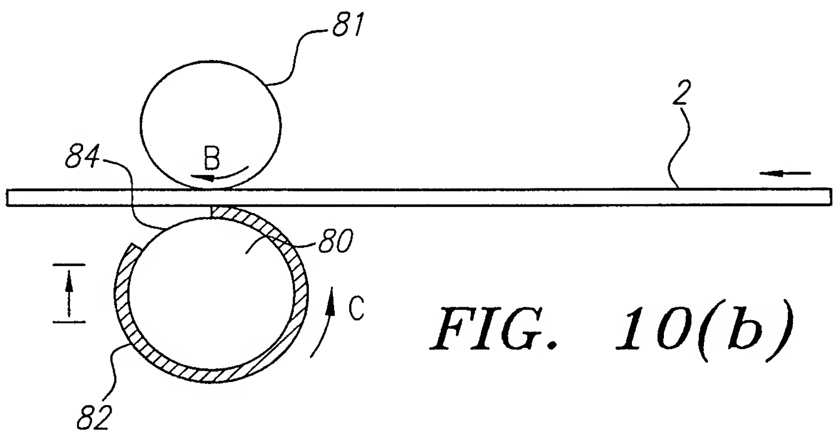

FIG. 10(b)

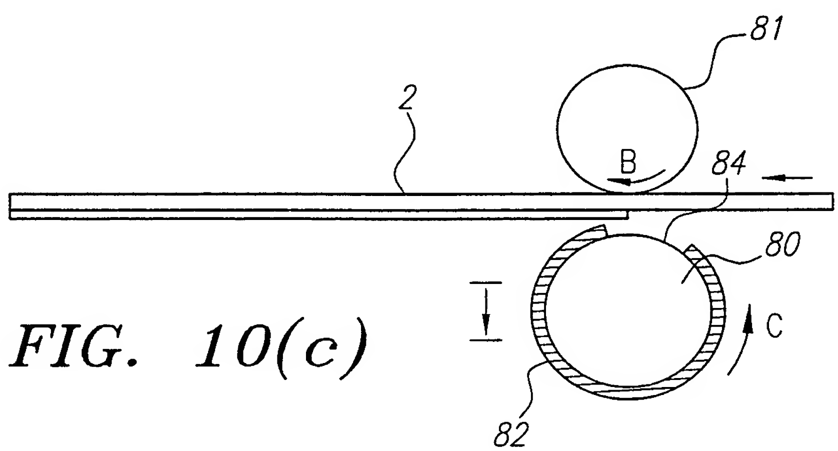

FIG. 10(c)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/15153

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B26D3/14 B31B1/22 B26D7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B26D B31B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	EP 0 752 299 A (SCM CONTAINER MACH LTD) 8 January 1997 (1997-01-08) the whole document ---	1-3,9 4-7 8
Y	GB 2 072 563 A (CAVAGNA E;COLOMBO A) 7 October 1981 (1981-10-07) page 1, line 1 - line 5 page 2, line 20 - line 25; figures ---	4-7
X	US 4 098 173 A (SCHAUMAN JAMES L) 4 July 1978 (1978-07-04) the whole document ---	1-3,9
A	US 4 543 863 A (RADER ROBERT R) 1 October 1985 (1985-10-01) abstract column 6, line 54 - line 56 --- -/--	4

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 September 1999	27/09/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vaglienti, G

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/15153

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 095 511 A (WOOLSTON ALLAN BRENT) 20 June 1978 (1978-06-20) column 3, line 1 - line 15; figures 1,2 ---	8
A	US 2 681 105 A (FITCHETT) 15 June 1954 (1954-06-15) the whole document ---	8
A	US 1 525 238 A (HURD) 3 February 1925 (1925-02-03) page 2, line 1 - line 10; figure 1 ---	8
A	DE 475 515 C (AKTIENGESELLSCHAFT FÜR CARTONNAGEINDUSTRIE) figures -----	8

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 99/15153

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims: 1-4,9: slotter unit driving means and method for operating the same
2. Claims: 5-7: slotter unit mounting means
3. Claims: 8: slotter unit including creasing heads

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

rnational Application No
PCT/US 99/15153

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